VII.C – Testing

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Outline

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Purpose of Software Testing

- Verify correct functionality of individual software elements
- Verify that software meets functional requirements
- Verify correct communications between elements
- Verify functionality of entire system in real world operations scenarios
- Test data volume and throughput requirements of the GSSC systems

Verification Methods

- The GSSC Functional Requirements Document lists the verification methods for each requirement.
- The verification methods—demonstration, inspection, analysis, test—are taken from the Mission System Specification.
  - Demonstration—observed compliance: requirements such as running the GI program can only be verified by an event
  - Inspection—visual proof of existence: requirements such as maintaining a website are verified by observing that a website exists!
  - Analysis—predicted performance using calculations: while satisfying the requirement awaits an event, tests can be extrapolated to show that the requirement will be satisfied. Very few GSSC requirements are in this category.
  - Test—measurement of performance: in most cases compliance will be tested in advance and then demonstrated in a formal practice event such as a Ground Readiness Test

Verification Matrix

- The GSSC maintains a Verification Matrix (GSSC-0002) tracking the compliance with its requirements.
- The GSSC CCB will note requirement verifications in the Verification Matrix Document.
- Because most of the requirements that will be verified by tests involve software, most of the test plan focuses on software.

Test Personnel

- GSSC Test Manager
  - Appointed by the GSSC Manager
  - Manages design and implementation of tests
  - Ensures tests are used consistently on an on-going basis
  - Tracks test results
- GSSC Test Teams
  - Appointed by GSSC Test Manager for a specific set of tests
  - Members are selected from GSSC staff and should exclude the author of the software being developed if possible.
  - Test Team Lead
    - Responsible for organizing Test Team's activities
    - Responsible for insuring that the test report is drafted and submitted on time
    - Cannot be the author of the software being tested

Testing Procedures I

- Test Preparation
  - Test goals defined
  - Prepare detailed list of test cases and test plan
  - Identify software needed for test
  - Identify and secure hardware needed for tests
  - Prepare test input data
- Configure and Build Software
  - Download and install version of software to be tested
  - Configure software for test
  - Build and Installation Documentation checked.
- Test Execution
  - Individual tests performed
  - Regression testing as needed
  - Identify any errors or problems

Testing Procedures II

- Initial Test Report
  - Test failures
  - Issues to be resolved
  - Recommended solutions
- Issue Resolution
  - Problems documented in GSSC Issue Tracking System
  - Corrections managed by Test Team Lead.
  - Issue closed at next test
- Retesting of Software
  - As issues are closed the Test Team will retest the affected software to verify that the issue has been successfully resolved
  - Results of rerun test to be included in final report

Testing Procedures III

- Final Test Report
  - Description of all hardware and software used
  - Complete list of all tests performed
  - Test objectives met
  - List of issues raised and their resolution
  - List of requirements satisfied by test
  - Recommendations for system improvement
  - Appendices should include all input and output files for future regression testing.
- Software Release
  - Once all tests are passed the software is certified for release
  - All future changes under control of CCB

Discrepancy Management I

- Issue Tracking
  - All error or discrepancies found during testing will be entered into the GSSC's Issue Tracking System.
  - Any recommended software enhancements or modifications will also be entered into the Issue Tracking System
- Issue Assignment
  - Assignment Responsibility
    - New, unreleased software – Software Manager
    - Previously released software – CCB
  - Assigns criticality to each issue
  - Assigns responsibility for resolution to GSSC staff members – usually the original developer

Discrepancy Management II

- Issue Resolution
  - All “critical” issues must be resolved before the software can be deemed to have passed the test in which the issue was raised.
  - All “critical” issues must be resolved at least 1 week before the scheduled release date
- Reporting
  - Responsible party will submit a report detailing what steps were taken and code changes made to resolve the issue
  - Reports become part of the final testing report for the test that generated the issue.
- Issue Closure
  - Once the corrected software has passed the retest, the Test Manager will mark the issue as resolved.
  - The CCB or Software Manager as appropriate will then officially close the issue.

Test Data Sources

- Test data for GSSC software systems will come from a variety of sources
  - In-house Simulators
  - IOCs
  - MOC
- Exact nature of test data needed and data sources for individual units and subsystems to be determined by the Test Team responsible for test execution.
- Data from lower level tests will flow into test sets used in higher level tests.
  - i.e. Unit Test data can be used as part of input for Subsystem Tests.

Types of Tests

- Unit Tests
  - These test the basic functionality of individual software components and verify that the functional requirements of the individual components are met.
  - Focus on correct operation and robustness in the presence of valid, invalid and incomplete data input.
- Subsystem Tests
  - These test the larger software subsystems, inter-system communications and subsystem performance.
  - These tests include analysis of data volume and throughput capabilities and the response time of various subsystems.
- System Tests
  - These are used to test the operation of the GSSC systems as a whole in real world scenarios that include interaction with ground system elements outside of the GSSC.

Unit Test Specifications

- Purpose
  - These test the basic functionality of individual software components and verify that the functional requirements of the individual components are met.
  - Focus on correct operation and robustness in the presence of valid, invalid and incomplete data input.
- Performed as needed to prepare software for larger system or end-to-end tests and as part of natural development cycle.
- Test code and data will be provided by the developers and distributed with the individual components.
- Nightly builds and execution of test software performed on each component.
- No formal reports generated

Example: D1 Server Testing

- Nightly builds – verifies that code compiles correctly
- Query Test – verifies proper functionality of D1 Server with valid and invalid query requests
- Ingest Test – verifies proper functionality of D1 Server with valid and invalid ingest requests

Subsystem Test Specifications

- Purpose
  - Test the larger software subsystems, inter-system communications and subsystem performance.
  - These tests include analysis of data volume and throughput capabilities and the response time of various systems.
- Conducted by GSSC Software Test Teams (GSTT)
- Performed as delimited in GSSC Test Plan to verify functionality and performance in preparation for software releases and system tests.

Example: D1 Database Testing

- Tests interaction between the Web Interface, Queue Manager, D1 Server and D1 Ingest components
- Verifies valid communications between connected components
- Verifies that data ingest and retrieval requirements are met
- Tests for error recovery and proper handling of system failures

System Test Specifications

- Purpose
  - These tests are used to test the operation of the GSSC systems as a whole in real world scenarios that include interaction with ground system elements outside of the GSSC.
- Conducted by GSTT and individuals from other Ground System units
- All GSSC systems involved in the System tests are tested informally in preparation for the formal test.
- Scheduled as needed to meet deadlines defined in the Mission Schedule
- Many System tests already scheduled
  - GSSC System Tests
  - Ground Readiness Tests (GRT)
  - End-to-End Tests
  - LAT Data Challenges

GSSC System Test Schedule

- The primary GSSC System Tests (GST) are tied to the software releases presented previously
  - GST1 (10/01/04) – tied to Software Release 1 (11/15/04)
  - GST2 (12/15/04) – tied to Software Release 2 (02/01/05)
  - GST3 (03/15/05) – tied to Software Release 3 (05/01/05)
  - GST4 (06/15/05) – tied to Software Release 4 (08/01/05)
  - GST5 (12/15/05) – tied to Software Release 5 (01/31/06)
  - GST6 (02/20/06) – tied to Software Release 6 (04/03/06)
  - GST7 (12/04/06) – tied to Software Release 7 (01/15/07)
- Many of the systems will be tested informally much earlier than their formal tests – e.g. prototype D1 and D2 database systems were tested from Dec. ’03 – Feb. ’04 as part of a LAT Data Challenge although not formally tested until GST4.

Ground Readiness Tests

These tests verify the functionality and interaction of various components of the GLAST ground system:

- GRT1 (02/15/05): Data Transfer to/from MOC and Level 0 data ingest
- GRT2 (04/15/05): Preliminary test of command and activity schedule flows to and from other GS components
- GRT3 (06/15/05): BAP Operations support, timeline creation and transmission
- GRT4 (09/01/05): Timeline ingest and Burst Alert Processing
- GRT5 (11/15/05): Ingest Level 1 data from IOCs
- GRT6 (03/15/06): GSSC Backup Level 1 pipelines, TOO handling, ingest Anomaly Reports
- GRT7 (05/15/06): Clean-up/Regression Testing – no new GSSC functionally tested

End-to-End Test Schedule

These tests show that the data will flow from the spacecraft all the way to delivery to the users.

- Six 2-day End-to-end (ETE) tests are currently scheduled
  - 02/11/06 – Basic Observatory T&C
  - 03/15/06 – Basic Command/Memory Management
  - 06/15/06 – Basic Observatory Operations
  - 08/25/06 – Advanced Operations
  - 10/14/06 – Regression & Additional Contingencies
  - TBD – Spacecraft at launch site

Data Challenges

- Three “Data Challenges” are scheduled in conjunction with the LAT team to test the LAT data pipeline, including the GSSC's databases, and the LAT data analysis software.
  - DC1 – completed 12/03–02/04 – 1 week's worth of simulated data
  - DC2 – Spring 2005 – 1 month's worth of simulated data
  - DC3 – Spring 2006 – 1 year's worth of simulated data

- Data generated for Data Challenges will provide test data for many of the Ground System and GSSC tests.

RFA #9 Resolution

- RFA #9: "The software testing plan includes no participation outside the GSSC. Personnel involved in software verification testing may not be sufficiently independent of the developers."

- All GSSC Staff Members participate in software development
- Plan to minimize developer involvement in testing was addressed in section on Testing Personnel
  - Test performed by GSSC staff other than the software developer
  - When software developer has to be involved, they may not be the Testing Team Lead.
- Most GSSC systems also tested as part of GRTs, ETEs or Data Challenges which are administered by Personnel outside of GSSC.

Summary

- Requirement verification is tracked by a Verification Matrix
- Formal GSSC Test Plan document has been baselined
- Most GSSC requirements that can be tested involve software; therefore the GSSC test plan deals predominantly with software
- Testing is an integral part of component development
- Unit level testing is already well underway for those components currently under development
- System level testing will occur prior to the GRTs and ETEs; compliance with GSSC requirements will be documented in these System tests